Photocathode R&D

An overview of research on high quantum efficiency, robust photocathodes

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C-AD electron-cooling

Photocathode Criteria

- High Quantum Efficiency
  - 0.5 A at 351 MHz (1/2 RF frequency) = 1.3nC/bunch
- Uniform emission surface
- Long lifetime
- Robust
- Reproducible preparation technique
- Photoemission at convenient laser wavelength

Research Goals

- Establish deposition system with a reproducible optimized recipe
- Study Lifetime related issues: Dependence on
  - laser intensity and wavelength
  - current density
  - Contaminants
  - Vacuum conditions
- Integration into load lock or diamond capsule

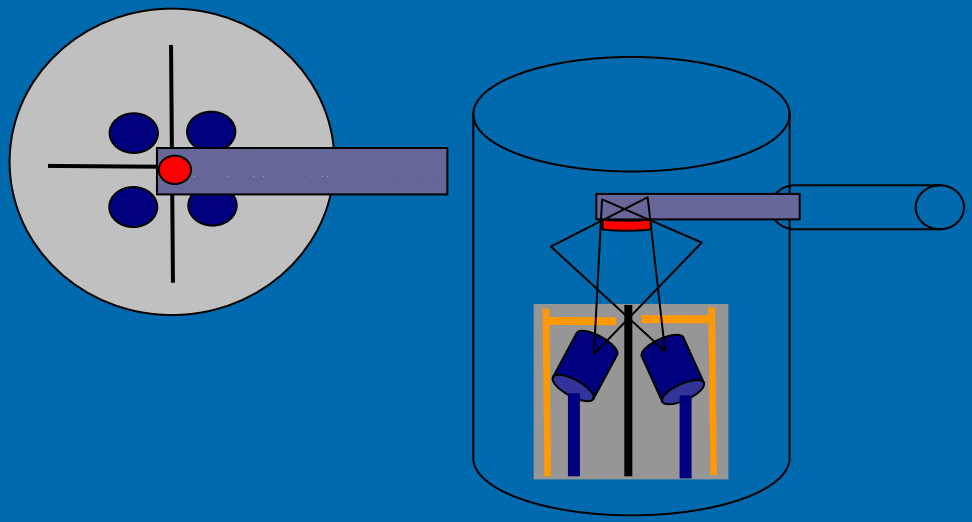
Cathode Options

Photocathode	CsK_2Sb	Cs_2Te	GaAs	Mg
Laser wavelength	532/355	266 nm	800 nm	266 nm
QE	3%/10%	3%	5-10%	.1%
Laser power to achieve .5A	38W/17W	77 W	15 W	2300 W
Prompt emission	Yes	Yes	No	Yes
Commercial Laser available	Yes	No	Maybe	No

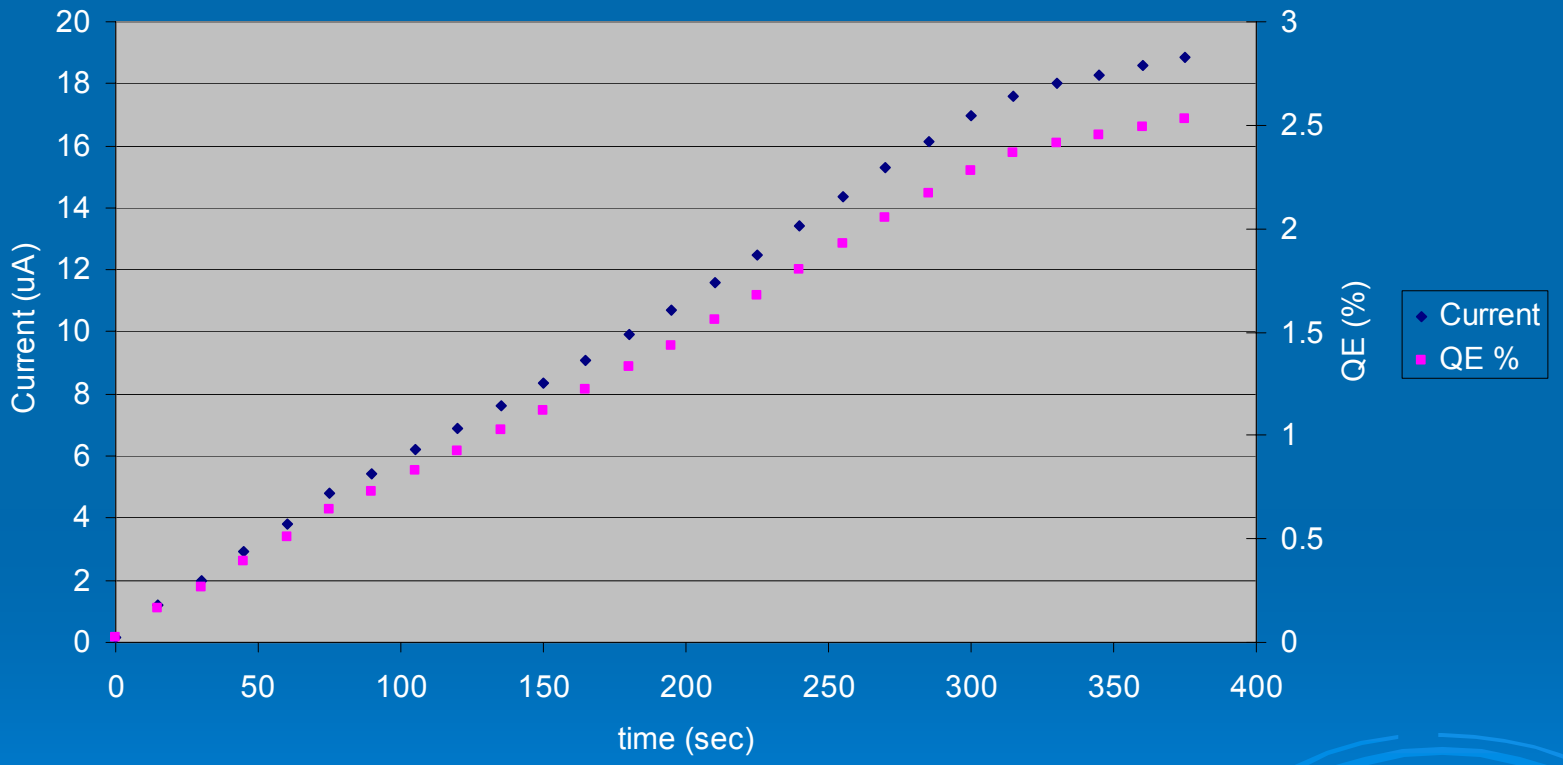
Photocathode Deposition System

Fabrication Procedure

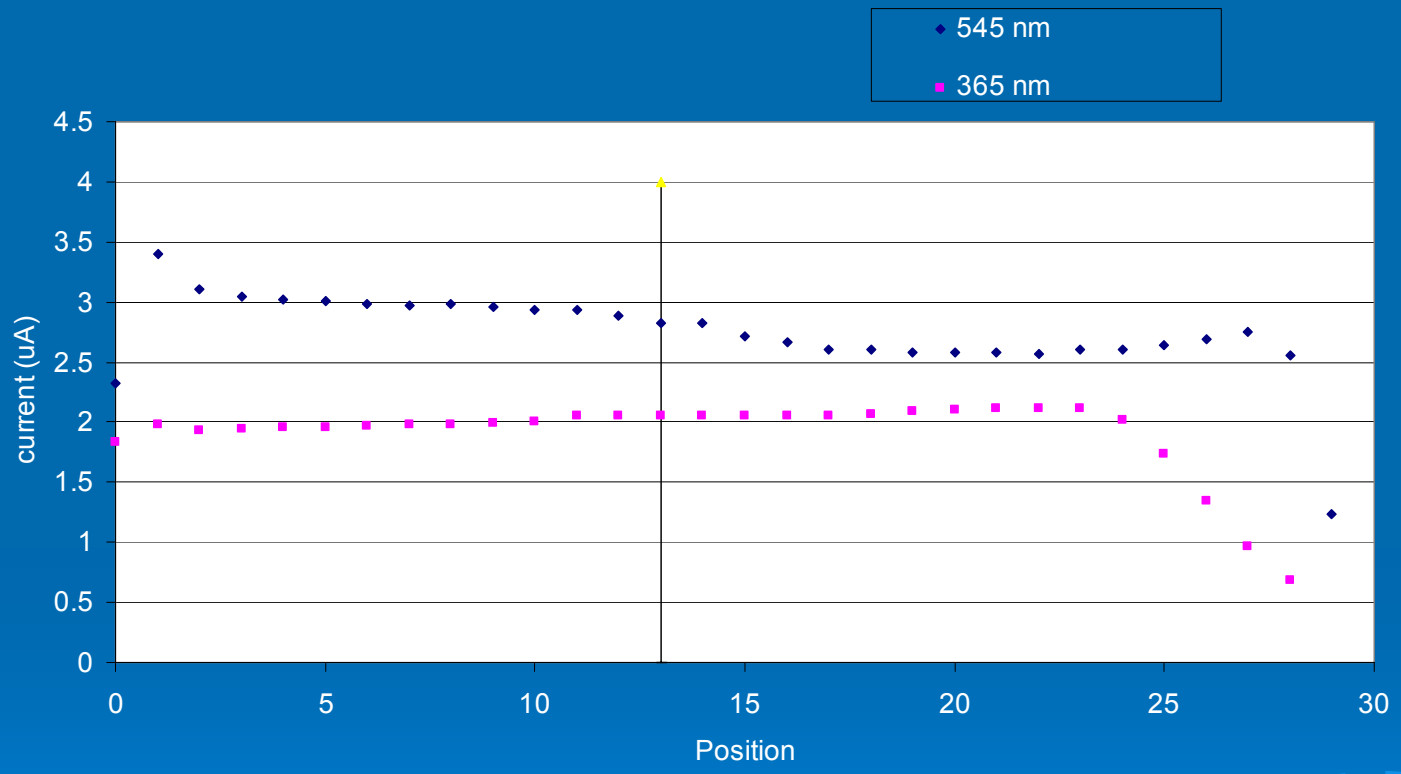
- Chemical Deposition system
- Polished 1” Molybdenum substrate
- Multi-stage deposition process
  - 200 Å Sb, 150 Å K, ~200 Å Cs
- Current is monitored as a function of Cs deposition



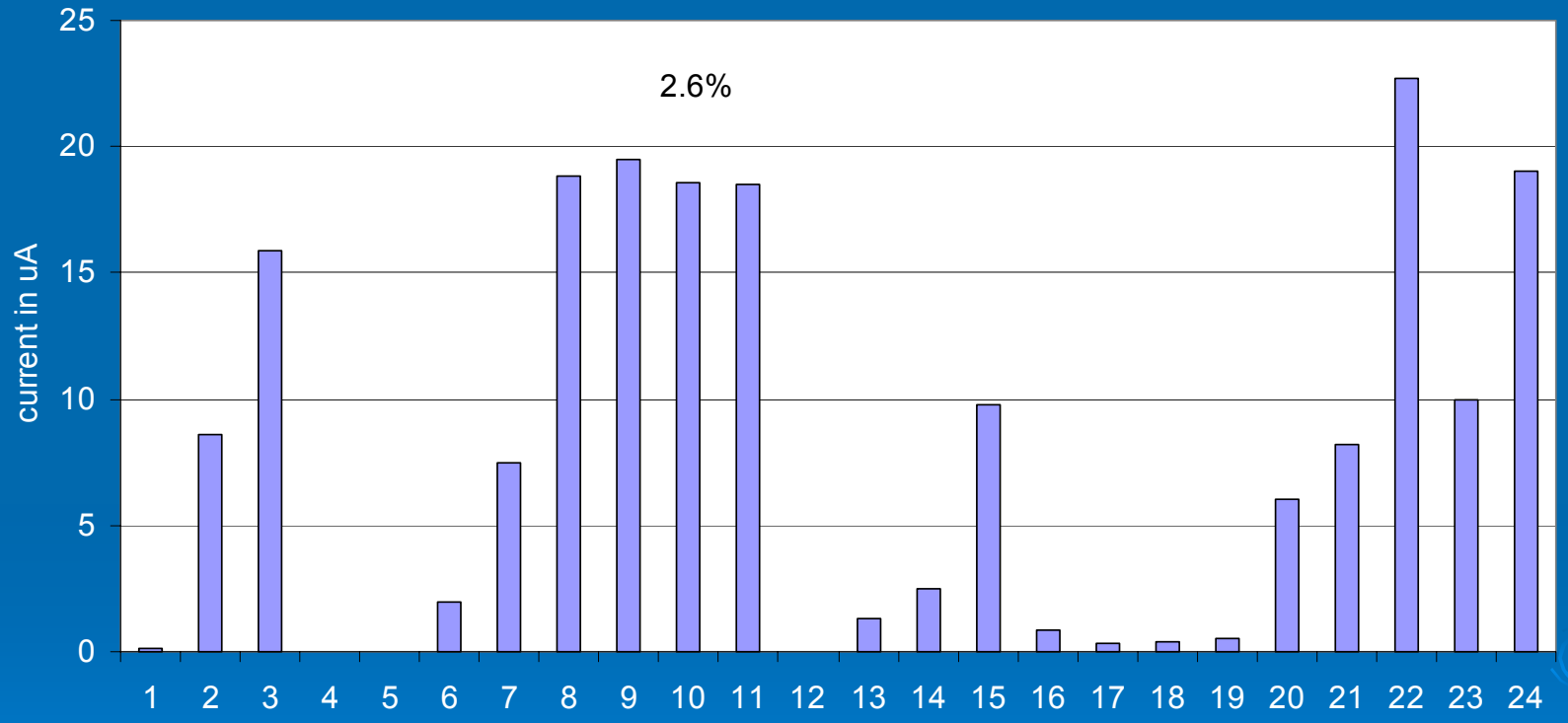
Current vs. Cs Deposition time



Surface Uniformity



Reproducibility



Lifetime Studies

Cathode Gun Interface

- Load-lock to attach deposition system to SCRF gun
- Capsule design with diamond window sealed onto photocathode
- Outcome of SEY program will determine final course taken

Laser System Requirements

- 351.875 MHz
- 532 nm, 355 nm
- 10 ps pulse length
- Synchronized to master RF clock
- Adjustable output power
- Variety of amplifier systems

Laser Requirements

Laser Wavelength	CsK_2Sb QE	SEY	Desired Current	Laser Power to Cathode
532 nm	3%	0	0.5 A	38 W
532 nm	3%	50	0.5 A	0.7 W
355 nm	9%	0	0.5 A	17 W
355 nm	9%	50	0.5 A	0.35 W

Laser Layout options

CsK_2Sb cathode in SCRF gun

Oscillator → multi-pass Amplifier Chain → Harmonic Conversion

1064 nm 351 MHz Few watts	Multi-pass Multi-stage Adjustable output power to 80 W	2nd or 3rd Harmonic 40 W green 20 W UV

CsK_2Sb cathode with diamond secondary emitter

Oscillator → Amplifier → Harmonic Conversion

1064 nm 351 MHz Few watts	Single pass (Optional)	2nd or 3rd Harmonic 1 W green 0.5 W UV

Conclusions

- Cathode research
  - Moderate QE obtained
  - Good surface uniformity
  - Lifetime and current density studies are promising
  - Reproducibility needs to be better
  - Different Substrate materials will be studied
- Laser System
  - Commercial oscillators are available
  - Outcome of SEY experiments will determine amplifier needs
- Cathode-Gun interface being addressed